

Serial No.: 10/644,567

PATENT APPLICATION
Docket No.: NC 84,613

REMARKS

Claims 1-10 and 12-21 are pending in the application. Claims 15-21 are added by this amendment. Claim 11 is canceled by this amendment without prejudice. No claims are presently allowed.

The paragraph beginning at page 3, line 15 has been amended to recite that the plasma can be 60 cm x 60 cm. Support for this amendment is found in Meger et al., *Physics of Plasmas*, 8(5), 2558-2564 (2001) (abstract). This publication was incorporated by reference into the instant specification at page 3, lines 17-22.

The paragraph beginning at page 4, line 29 has been amended to recite that the electron beam energy may be 1-5 keV. Support for this amendment is found in Meger et al., US Patent 5,874, 807, col. 4, line 3. This patent was incorporated by reference into the instant specification at page 3, lines 17-22.

The paragraph beginning at page 5, line 13 has been amended to recite that the plasma electron energy may be up to 1.5 eV. Support for this amendment is found in Meger, *Physics of Plasmas*, at page 2559, right column, first full paragraph.

Claim 1 has been amended to cancel "large area" from the preamble. As the preamble is not a limitation of the claim, the amendment does not affect the scope of the claims.

Claim 1 has been amended to recite that the electron beam source is capable of sustaining an electron beam having an average electron energy of at least about 1 keV in 10 mTorr of oxygen. Support for this amendment is found in the paragraph beginning at page 4, line 29, as amended and at page 6, line 13 and page 5, line 7.

Claim 1 has been amended to change "low" to "about 1.5 eV or lower." Support for this amendment is found in the paragraph beginning at page 5, line 13, as amended.

Claim 1 has been amended to cancel "geometrically well defined, spatially uniform" and to recite the limitations regarding the plasma sheet as limitations of the magnetic means, so that the plasma sheet is not itself an element in the claimed system.

Claim 1 has been amended to recite "source location" and "substrate location" instead of "target" and "substrate," so that the source and substrate are not elements of the claimed system. The locations are inherent parts of the system in that the source and substrate must be held by or resting on some location of the system.

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Claim 1 has been amended to recite that the source location comprises one or more of sputtering means and vaporization means. Support for this amendment is found in now canceled claim 11.

Claim 1 has been amended for consistency to recite that the sputtered or evaporated material is deposited, and to cancel "by the plasma" as the means for the sputtering or evaporation.

Claim 2 has been amended to specify a sputtering source.

Claims 2 and 6 have been amended to change "target" to "source" for consistency.

Claim 7 has been amended to change "said film or coating material source" to "said material source."

Claim 8 has been amended to cancel two of the recited alternatives.

Claims 12-14 have been amended to correct their dependency to claim 1 and to cancel "hybrid" for consistency with the preamble of claim 1.

Claim 14 has been amended to change "electron beam produced plasma" to "plasma sheet." The missing period at the end of the claim has been added.

New claim 15 recites a minimum length and width for the plasma. Support for this amendment is found in the paragraph beginning at page 3, line 15, as amended.

New claim 16 recites a method of using an apparatus similar to that recited in claim 1.

New claims 17-21 are dependent method claims reciting limitations similar to those in claims 2-5 and 10 respectively.

Claim Rejections – 35 U.S.C. § 112

Claims 1-14 have been rejected under 35 U.S.C. § 112, second paragraph as being allegedly indefinite for failing to particularly point out and distinctly claim the subject matter which Applicants regard as the invention.

As to claims 1 and 11, the claims were rejected for a lack of basis for comparison for the term "large." The term has been canceled from the claim 1 and claim 11 has been canceled.

Further as to claim 1, the claim was rejected for a lack of basis for comparison for the term "low." The term has been changed to the numerical range of about 1.5 eV or lower.

As to claim 7, the claim was rejected for lack of antecedent basis for "said film of coating material source." As suggested by the Examiner, this has been changed to "said material

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source.”

As to claim 8, the claim was rejected for a lack of basis for comparison for the term “hot.” The term has been canceled from the claim.

As to claim 11, the claim was rejected for incorporating only some of the limitations of its parent claim 1. The claim has been canceled.

As to claims 12 and 13, the claims were rejected for incorrect claim dependency. The dependencies of 12-14 have been corrected to independent claim 1.

As to claim 14, the claim was rejected for lack of antecedent basis for “electron beam produced plasma.” This has been changed to “plasma sheet.”

Claim Rejections – 35 U.S.C. § 102

Claims 1-3, 7-9, and 11 have been rejected under 35 U.S.C § 102(b) as allegedly anticipated by Moseson (US 3,393,142).

Claim 1 is directed to a plasma deposition system, comprising an electron beam source, magnetic means, a source location, and a substrate location. The electron beam source has a width much larger in dimension than its thickness and is capable of sustaining an electron beam having an average electron energy of at least about 1 keV in the presence of 10 mTorr of oxygen. The magnetic means is for confining the beam so as to produce a plasma sheet. The plasma sheet is of pre-determined width, length, thickness, and location and has an electron temperature of about 1.5 eV or lower. The source location is for a material source and comprises sputtering means, vaporization means, or both. The substrate location is for a substrate upon which material sputtered or evaporated from the source is deposited.

Moseson discloses a cathode sputtering apparatus. The apparatus includes a filament cathode and an anode held at a voltage difference of about 40 V (col. 5, line 15) to produce an electron sheet. The electron sheet produces a plasma between a target and a substrate.

In order to make a *prima facie* case of anticipation, the reference must disclose each limitation of the claim. The reference does not disclose the limitation recited in claim 1 that the electron beam source is capable of sustaining an electron beam having an average electron energy of at least about 1 keV in the presence of 10 mTorr of oxygen. In Moseson the anode to cathode voltage is only 40 V, corresponding to an electron energy of 40 eV. This is much smaller than the claimed range. If higher voltages and/or higher oxygen pressures were used in

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the apparatus of Moseson, the filament would rapidly oxidize and burn up.

The present invention as recited in claim 1 uses a cathode, such as a hollow cathode beam source, that can withstand high voltages at a relatively high oxygen or other reactive gas pressure. This can result in a system that may operate in any gas, over a wide range of pressures, for long lifetimes, and deposit uniform films over larger areas. These advantages are not present in filament based systems such as in Moseson. It should be noted that new filaments could be developed that are able to operate in oxygen, and that such filaments would be within the scope of the present claims.

Claims 2, 3, and 7-9 depend from and contain all the limitations of claim 1 and are asserted to distinguish from the reference in the same manner as claim 1. Claim 11 has been canceled.

Claim Rejections – 35 U.S.C. § 103

Claims 1, 4, 5, and 10 have been rejected under 35 U.S.C § 103(a) as allegedly unpatentable over Moseson in view of Oda et al. (US 3,436,332).

Oda discloses a sputtering apparatus using a filament cathode. The anode to cathode voltage is 60-100 V (col. 2, lines 55-56).

In order to make a *prima facie* case of obviousness, each claim limitation must be disclosed in the references. Oda does not disclose the limitation in claim 1 (claims 4, 5, and 10 dependent thereon) that the electron beam source is capable of producing an electron beam having an average electron energy of at least about 1 keV in the presence of 10 mTorr oxygen. As in Moseson, the filament of Oda would quickly burn up under such conditions. As all the claim limitations of claim 1 are not disclosed in the reference, a *prima facie* case of obviousness has not been made.

Claims 4, 5, and 10 depend from and contain all the limitations of claim 1 and are asserted to distinguish from the reference in the same manner as claim 1.

Claims 1, 6, 11, and 12 have been rejected under 35 U.S.C § 103(a) as allegedly unpatentable over Moseson in view of Hurwitt et al. (US 6,416,635). Hurwitt discloses a sputtering apparatus where the target is moveable with respect to the substrate (abstract). The target is the source of both the electrons and the sputtered material (col. 1, lines 13-29).

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Hurwitt does not disclose an electron beam source as recited in claim 1 (claims 6 and 12 dependent thereon). Instead, the target itself emits electrons. As explained above, Moseson does not disclose the electron beam source either. As all the claim limitations of claim 1 are not disclosed in the reference, a *prima facie* case of obviousness has not been made.

Claims 6 and 12 depend from and contain all the limitations of claim 1 and are asserted to distinguish from the reference in the same manner as claim 1. Claim 11 has been canceled.

Claims 11, 13, and 14 have been rejected under 35 U.S.C § 103(a) as allegedly unpatentable over Moseson in view of Bunshah et al. (US 4,336,277). Bunshah discloses a physical vapor deposition system using a filament in a very low concentration of oxygen.

Bunshah does not disclose the limitation in claim 1 (claims 13 and 14 dependent thereon) that the electron beam source is capable of producing an electron beam having an average electron energy of at least about 1 keV in the presence of 10 mTorr oxygen. As in Moseson, the filament of Bunshah would quickly burn up under such conditions. Although some oxygen is present in Bunshah, it appears that the oxygen pressure is only 0.1 mTorr at the most (col. 4, lines 52-56). Although filaments may survive such low oxygen levels, they would burn up at 100 times that level of oxygen as recited in claim 1. As all the claim limitations of claim 1 are not disclosed in the reference, a *prima facie* case of obviousness has not been made.

Claims 13 and 14 depend from and contain all the limitations of claim 1 and are asserted to distinguish from the reference in the same manner as claim 1. Claim 11 has been canceled.

Claims 1-3, 7-9, and 11 have been rejected under 35 U.S.C § 103(a) as allegedly unpatentable over Moseson in view of Meger et al. (*Physics of Plasmas*). Meger discloses an electron beam source that is wider than it is thicker.

In order to make a *prima facie* case of obviousness, there must be a motivation to combine the references. The Examiner stated that the motivation for utilizing an electron beam that is wider than its thickness is to allow for greater control and larger area production of plasmas, citing to the abstract of Meger. This is not a correct reading of Meger. The abstract says that moderate energy e-beams can provide greater control and larger area, without reference to the dimensions of the beam. Further, Meger states that the greater control and larger area are for processing applications. Deposition techniques are not stated as a processing application of

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the moderate energy e-beams. Thus, there is no motivation to use the e-beam of Meger in the apparatus of Moseson.

It is not obvious to use the e-beam of Meger for deposition because, for example, the higher energy electrons of Meger do not have an optimized ionization cross-section for a given gas. Low energy electrons, such as in Moseson have a large ionization cross-section and are thus very likely to collide with and ionize the gas. Increasing the energy would decrease the ionization cross-section and reduce the amount of plasma formed per length of electron travel. However, Moseson teaches the desirability of a strong plasma (col. 3, lines 56-57) and so a person of ordinary skill would not be motivated to increase the energy of the e-beam. A nonobvious advantage of the present invention is that electron energies above 1 keV produce plasma more uniformly and efficiently over longer beam lengths. Higher energy electrons are more likely to go a greater distance before ionizing the gas and less likely to have non-ionizing collisions or elastic collisions. Hence, ionization and thus plasma production is more uniform over the entire length of the beam and the efficiency improves since less energy is lost to elastic collisions. This advantage is not limited to gas pressure or type, including reactive gases. Nothing in the references suggests that this would be useful for sputtering or other deposition techniques. As there is no motivation to combine, a *prima facie* case of obviousness has not been made.

Claims 2, 3, and 7-9 depend from and contain all the limitations of claim 1 and are asserted to distinguish from the reference in the same manner as claim 1. Claim 11 has been canceled.

Claims 4, 5, and 10 have been rejected under 35 U.S.C § 103(a) as allegedly unpatentable over Moseson in view of Meger and further in view of Oda.

As explained above in reference to the rejection of claim 1 over Moseson and Meger, there is no motivation to combine the e-beam of Meger with deposition techniques such as in Moseson and Oda. Claims 4, 5, and 10 depend from and contain all the limitations of claim 1 and are asserted to distinguish from the reference in the same manner as claim 1.

Claims 6 and 12 have been rejected under 35 U.S.C § 103(a) as allegedly unpatentable over Moseson in view of Meger and further in view of Hurwitt.

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As explained above in reference to the rejection of claim 1 over Moseson and Meger, there is no motivation to combine the e-beam of Meger with deposition techniques such as in Moseson and Hurwitt. Claims 6 and 12 depend from and contain all the limitations of claim 1 and are asserted to distinguish from the reference in the same manner as claim 1.

Claims 13 and 14 have been rejected under 35 U.S.C § 103(a) as allegedly unpatentable over Moseson in view of Meger and further in view of Bunshah.

As explained above in reference to the rejection of claim 1 over Moseson and Meger, there is no motivation to combine the e-beam of Meger with deposition techniques such as in Moseson and Bunshah. Claims 13 and 14 depend from and contain all the limitations of claim 1 and are asserted to distinguish from the reference in the same manner as claim 1.

In view of the foregoing, it is submitted that the application is now in condition for allowance.

In the event that a fee is required, please charge the fee to Deposit Account No. 50-0281, and in the event that there is a credit due, please credit Deposit Account No. 50-0281.

Respectfully submitted,



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